NASA Johnson Space Center Space (JSC) Life Sciences Cancer and Related Research
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JSC researchers study carcinogenesis, cancer prevention and treatment along with epidemiological (primarily retrospective and longitudinal) studies, modeling, and interactions with the environment such as radiation, nutritional, and endocrine changes related to space flight along with behaviors such as smoking.

Cancer research is a major focus for human space flight due to the exposure to space radiation which consists of particles of varying charges and energies, and secondary neutrons. The JSC laboratories collaborate with investigators from the U.S. as well as our European and Japanese partners. We use accelerator facilities at the Brookhaven National Laboratory, Loma Linda University and Los Alamos National Laboratory that generate high energy charged particles and neutrons to simulate cosmic radiation and solar particle events. The research using cultured cells and animals concentrates on damage and repair from the level of DNA to organ tissues, due to exposure to simulated space radiation exposure, that contribute to the induction of leukemia and solid tumors in most major tissues such as lung, colon, liver and breast. The goal of the research is to develop a mathematical model that can predict cancer morbidity and mortality risks with sufficient accuracy for a given space mission.

For cancer prevention, JSC researchers have been investigating carbon nanoparticles as potential biomedical countermeasures for space radiation exposure. A modified fullerene (C60) with low toxicity has been demonstrated to reduce chromosome aberrations in cultured human cells after exposure to high energy protons and Fe ions, making the nanomaterial a potential candidate to be further evaluated for mitigation of space radiation-induced cancer risks.

JSC research has also contributed to the field of radiation therapy for cancer using high energy protons and carbon ions which has become increasingly popular. Sensitization of tumor cells to radiation treatment has been one of the research areas in cancer research. Preliminary studies conducted at JSC have demonstrated that chemicals targeting autophagy and other DNA repair pathways may have a radiosensitizing effect.

NASA JSC developed the “NASA Bioreactor” that has led to high fidelity Earth-based medical research. This invention is used extensively at JSC and as well as laboratories around the world for research in cancer, regenerative medicine, artificial organs, diabetes, AIDS, vaccine production, and infectious disease, among others. It enabled enhanced research in academia, medical centers, industry, and government. Tissue produced in the “NASA Bioreactor” is of exceptionally high quality and function, an advantage over conventional tissue culture methodology, for a broad range of medical applications. Tissue types grown include normal and transformed versions of skin, muscle, bone, cartilage, heart, pancreas, liver, prostate, and numerous others. The NASA Bioreactor enables the ability to expand tissue such as cartilage for both potential transplantation as well as characterization of abnormal conditions such as osteoarthritis, a condition that affects more than 26 million Americans. In the field of cancer research, this methodology

enabled the creation of 3-dimensional high fidelity tumor models of colon, ovarian, breast, neuronal, prostate, and others. The *higher in-vitro* fidelity of tumors achieved in the NASA bioreactor enables better agreement with the observed *in-vivo* physiology enabling new understanding of factors controlling cell growth, differentiation, tumor-stromal inductive interactions, and genetic expression control mechanisms. These are crucial methods for the evaluation of therapeutic treatments and causative agents of disease.

Collaborators at Emory University, utilizing enhanced *in-vitro* 3-dimensional tissue culture in the NASA Bioreactor, demonstrated improved tissue formation composed of both normal prostate stroma connective matrix and prostate epithelial cancer cells. The improved function of this *in-vitro* model of prostate cancer demonstrated the pathophysiology of the prostate epithelium under control by host endocrine factors. Prostate tumors grown in the NASA Bioreactor, which emulates microgravity even on Earth, allowed accurate associations of the required cells into a 3-dimensional tissue and elicited unique Prostate Specific Antigen (PSA) secretion responses not obtained by conventional methods. The NASA Bioreactor enables important tumor-stromal interactions, for both normal and transformed tissue growth, in a manner not possible by conventional culture methods. The “NASA Bioreactor” is planned to be a core facility in the orbiting ISS National Laboratory and primarily managed at JSC for advanced tissue culture and tissue engineering research.

JSC biomedical research includes all the areas related to human space flight. These investigators focus on individual tissues and systems as well as the interactions between various disciplines. Our biomedical research includes cardiovascular, cognition and behavior, exercise physiology, immunology and endocrinology, muscle physiology, nutrition, microbiology, pharmacology, and toxicology. NASA biomedical program has been central to innovative developments and use of technologies from the first bone mass scans to alternative uses of ultrasound for understanding changes for vision research. Although the primary focus is the development of countermeasures, our scientists have collaborations on mechanistic and tissue culture studies with external investigators from many universities, other national laboratories, as well as industry.